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ABSTRACT

This paper presents the results of a review of 26 research articles, discussing the importance, frequency, and realization of hedges in science research article. It also considers why students find hedging so difficult to master and raises implications thereof. The need to present scientific claims with precision and caution means that hedges are a significant resource for academics in anticipation of the reader's possible rejection of their propositions. As a result, English for Specific Purposes (ESP) students are often advised to avoid hedges and to adopt a detached style in their writings. Clearly, the ability to hedge statements appropriately is essential to effective scientific communication and academic success. The need to carry out research and publish results in English language journals presents non-native speakers with serious problems, especially regarding the research article genre in academic disciplines. A higher priority for hedging in both teaching and research agendas is recommended. ESP teachers need to move beyond the view that scientific writing is simply detached and factual and that hedges are merely conventions of the academic culture. (Contains 30 references.) (NAV)

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The Author in the Text: Hedging Scientific Writing

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Abstract

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Despite a widely held view that scientific writing is purely objective and impersonal, the means by which scientists convey an attitude to their statements is central to scientific argument. The need to present claims with precision and caution means that hedges are a significant resource for academics in anticipating the reader's possible rejection of their propositions. Despite its importance however, we know little about how hedging is expressed or the functions it serves in different disciplines or genres. As a result, ESP students are often advised to avoid hedges and to adopt a detached style in their writing. Based on a corpus of 26 research articles, this paper discusses the importance, frequency and realisation of hedges in science research articles. It also considers why students find hedging so difficult to master and raises a number of implications of this.

Introduction

Hedging is the expression of tentativeness and possibility in language use and it is crucial to scientific writing where statements are rarely made without subjective assessments of truth:

- (1) This insertion, which we suspect is the membrane anchor, could associate peripherally with the membrane or might span half the bilayer ...
- (2) Possibly, phosphorylation of ACC synthase could contribute ...
- (3) It now seems possible that the oxygen carrier function may be feasible because if the hemoglobin in the root were mainly in the tip, it ...

Hedges (underlined) indicate interpretations and allow writers to convey their attitude to the truth of the statements they accompany, thereby presenting unproven claims with caution and softening categorical assertions. These are central functions in an environment where the need to evaluate evidence and state the certainty of judgements can contribute to gaining the acceptance of knowledge claims. Hedging is a substantial means by which the professional scientist confirms his or her membership of the scientific community. Its study can therefore make an important contribution to our understanding of the practices of practical reasoning and persuasion in science.

A better understanding of hedges can provide insights into the interactional and rhetorical nature of the scientific research article (RA). The RA is now widely seen as less a vehicle for directly transmitting facts about the natural world than a significant literary accomplishment; a social artefact which conceals the contingency of knowledge while seeking to persuade readers to accept claims (eg Gilbert and Mulkay, 1984;

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Bazerman, 1988). Scientific knowledge involves the consensus of the research community and hedges are an important rhetorical device in acknowledging the reader's role in ratifying claims.

An understanding of hedges also has important implications for ESP teaching where the notion that academic writing is purely objective, impersonal and informational dies hard. While most applied linguists would accept that all prose is an interaction between a writer and an audience (eg Perfetti and McCutchen, 1987), style guides, writing textbooks and ESP courses continue to inform students that scientific research articles represent a kind of faceless discourse which minimises author involvement (Hyland, 1994). The advice frequently given is to strictly avoid tentative expressions altogether (eg Winkler and McCuen, 1989), the idea being that the facts must be allowed to speak for themselves with no human intrusion. Here the study of hedges can assist non-native speakers (NNSS) to participate more fully and successfully in the world of academic research.

This paper examines the importance of hedging in cell and molecular biology research articles and characterises its extent and major forms of realisation in this genre. It is based on a corpus of 75,000 words taken from 26 RAs in the six leading journals in the field, identified by expert informants and the Journal Citation Reports. It is part of a larger study into hedging in academic writing and therefore reports work in progress. My goal is to provide an overview of hedging in this genre, what it is, why it is used and how it is signalled. I will then briefly discuss why second language students find hedging difficult and point to some general issues that this raises.

What is hedging?

Hedging has been a subject of interest to linguists since Lakoff (1972) first used the term to describe "words whose job it is to make things more or less fuzzy" and has since been used to refer to devices which qualify the writer's expression (eg Skelton, 1988; Prince et al, 1982). Essentially it represents an absence of certainty and is used here to describe any linguistic item or strategy employed to indicate either a) a lack of commitment to the truth value of an accompanying proposition or b) a desire not to express that commitment categorically. The term does not therefore include other attitudinal markers or devices which convey the writer's conviction; items are only hedges in their epistemic sense and only then when they mark uncertainty.

The concept has received most attention in its role in casual conversation where it is probably twice as frequent as in written discourse and helps speakers to create a convivial atmosphere, facilitate discussion, show politeness or hide a deficit of knowledge or vocabulary (eg Coates, 1987). Some writers have suggested that hedges are a means of signalling distance between a speaker and what is said (eg Prince, et al, 1982; Rounds, 1982) or to convey purposive vagueness in writing (eg Stubbs, 1986; Myers, 1989; Channell, 1994). Hedges have also been treated as a form of metadiscourse directing readers as to how they should evaluate propositions (eg Crismore and Farnsworth, 1990). Despite this interest however, there has been little work into how hedges work in academic genres based on analyses of adequate corpora and we know virtually nothing about the expression and function of hedges in scientific RAs.

The functions of hedging in scientific writing

Essentially hedges in academic writing signal a writer's anticipation of the possibility of opposition to his or her statements. While they exhibit indeterminacy of meaning, and there is inevitably some overlap between these categories, hedges serve three main functions in gaining reader acceptance of claims.

First hedges allow writers to express propositions with greater precision in areas often characterised by reformulation and reinterpretation. Hedging here is an important means of accurately stating uncertain scientific claims with appropriate caution. Scientific writing is a balance of fact and evaluation as the writer tries to present information as fully, accurately and objectively as possible. So writers often say "*X may cause Y*" rather than "*X causes Y*" to specify the actual state of knowledge on the subject. Hedges here distinguish the actual from the potential or inferential and imply that a proposition is based on the writer's

plausible reasoning rather than certain knowledge. Readers are expected to understand that the proposition is true as far as can be determined.

The second reason concerns the writer's desire to anticipate possible negative consequences of being proved wrong. We gain our academic credibility by stating the strongest claims we can for our evidence, but we also need to cover ourselves against overstating our case. Hedges here help writers avoid personal responsibility for statements in order to protect their reputations and limit the damage which may result from categorical commitments. This usage follows Lakoff in associating hedges with "fuzziness", but I'm not using fuzziness to describe propositional connections; here hedges are used to blur the relationship between a writer and a proposition when referring to speculative possibilities. This is usually achieved through modal devices used in non-agentive environments - either by use of the passive, existential subjects (4) or of 'abstract rhetors' which attribute judgements to the text or the findings (5 and 6):

- (4) It was assumed that the phosphorylation of EF-2 may play a ...
- (5) These data indicate that phytochrome A possesses the intrinsic ...
- (6) The model implies that the function of grana is to shield varying amounts of ...

In science writers may hedge in this way because of preliminary results, small samples, doubtful evidence, uncertain predictions, imperfect measuring techniques.

Finally hedges contribute to the development of the writer-reader relationship, addressing the need for deference and cooperation in gaining reader ratification of claims. Mitigating the illocutionary force of speech acts is common in conversation where it has been linked to the expression of deference or strategic politeness. In science however, writers must consider both the reader's role in ratifying knowledge, and the need to conform to community expectations on limits of self-assurance. Quite simply, categorical assertions leave no room for dialogue and are inherently face-threatening to others. They indicate that the arguments need no feedback and relegate the reader to a passive role. Explicit reference to the writer seems to mark the statement as an alternative view rather than a definitive statement of truth, indicating a personal opinion awaiting verification:

- (7) Thus we propose that this insert is the major site of interaction with the membrane....
- (8) I believe that the major organisational principle of thylakoids is that of continuous unstacking and restacking of sections of the membrane

Here hedges appeal to readers as intelligent colleagues, capable of deciding about the issues, and indicate that statements are provisional, pending acceptance by one's peers. This interpersonal role is backed up by institutionally reinforced obligations concerning the need to defer to and engage in debate with the scientific community. In sum, hedging looks 3 ways: towards the proposition, the writer and the reader.

Surface features of hedging

Academic writing is extensively hedged. My corpus shows that hedging represents more than one word in every 50 and this is supported by numerous studies looking at "authorial comment" which have all found one hedge every two or three sentences (eg Skelton, 1988; Adams Smith, 1984; Hanania and Akhtar, 1985). This indicates a level of frequency much higher than many features of scientific discourse which traditionally get much more attention in ESP courses.

Holmes (1988) has identified over 350 markers of mitigation in conversation and while the range of items is more restricted in scientific discourse, a large number of different devices occur. The formal and strategic categories are shown in Table 1.

Table 1: Relative frequency of various categories used to express hedging in Journal corpus

Category	Items per 1,000 words	percent	Raw number
lexical verbs	4.9	23.3	366
adverbial constructions	4.4	21.0	329
adjectives	3.9	18.8	294
modal verbs	3.5	16.6	259
reference to limiting conditions	1.3	6.1	97
modal nouns	1.1	5.4	85
reference to a model, theory or methodology	1.1	5.3	83
admission to a lack of knowledge	0.7	3.5	55
Totals:	20.9	100	1568

Lexical markers

Hedging is principally a lexical phenomenon, but while linguists have generally been pre-occupied with modal verbs (eg Coates, 1983; Palmer, 1990) this data demonstrates the importance of other forms of hedging to native speakers. Overall frequencies show the particular importance of lexical verbs, modal verbs, epistemic adverbs and adjectives in expressing hedging in the RAs.

Lexical verbs constituted the greatest range of items with 38 different forms represented with *indicate*, *suggest*, *appear* and *propose* constituting 55.7% of all instances. All four verbs, and particularly *indicate* and *suggest*, appear to be more prominent in scientific writing than in the heterogenous academic texts in the Brown/LOB corpora. The most frequently occurring modal adjectives were *likely*, *possible*, *most* and *consistent with*. Over 36 adverbial forms were identified in the RA data which included 'downtoners' (Quirk et al, 1972: 542ff), such as *quite*, *almost* and *usually* which lower the effect of the force of the verb, and disjuncts that convey an attitude to the truth of a statement (eg *probably*, *generally*, *evidently*). Some 65% of the modal verbs in the corpus were used epistemically. *Would*, *may* and *could* were the most frequent epistemic forms and these accounted for 76.6% of the total, suggesting that a more restricted range is used in scientific writing than in conversation. Modal nouns, such as *possibility*, *assumption*, *estimate* and *tendency* are less significant in the RAs. Interestingly, hedges tend to reinforce one another in clusters with 43% of hedges occurring in the same sentence as at least one other device.

Particular devices appear to differ across domains however as Holmes' data for the academic sections of the Brown and LOB corpora and informal and semi-formal sections of the Lund corpus of English speech shows (Table 2).

Table 2: Relative frequency (%) of grammatical categories used to express epistemic modality

Class	Journal corpus	Holmes' Corpus			Total
		Writing	Speech		
Lexical verbs	27.4	35.9	31.5	33.3	
Adverbials	24.7	12.8	21.5	18.1	
Adjectives	22.1	6.6	2.3	4.0	
Modal verbs	19.4	36.8	42.4	40.2	
Nouns	6.4	7.7	2.3	4.5	

Scientific writers make less use of modal verbs to express degrees of confidence in their statements, for example, employing more adjectives and adverbial forms, which are particularly striking when compared with more general academic writing. Nouns are of relatively marginal importance in all corpora.

Strategic markers

In addition to lexical items, there are a number of strategies that provide a significant means of hedging scientific statements, accounting for 15% of all hedges in the corpus. The most numerous strategies are those which qualify commitment by referring to experimental weaknesses or to shortcomings in the model, theory or methodology. The frequencies of these strategies are shown in Table 3.

Table 3: Most frequently occurring hedging strategies in corpus

Category	%	number	average per RA
reference to limiting experimental conditions	41.3	97	3.7
reference to a model, theory or methodology	35.3	83	3.2
admission to a lack of knowledge	23.4	55	2.1
Totals:	100	235	9.0

By commenting on the state of existing knowledge, writers can display how much confidence they invest in them, distinguishing between conclusions which are true under certain conditions and speculative possibilities. Some examples help 'frame' the proposition in a suitable environment of uncertainties and probabilities (6) while other cases simply signal possible alternative explanations (7):

(9) We do not know whether the increase in intensity of illumination from 250 to 1000 $\mu\text{E/m}^2$ per s causes induction of one specific....

(10) One cannot exclude a possibility that the activity of EF-2 Kinase in wheat germ is inhibited at a given stage of ontogenesis in some manner ...

Writers also refer to deficiencies in the research model (11), theory (12) or method (13) to hedge the certainty of their claims, allowing the prudent researcher to anticipate challenges to the premises or methods by which results were achieved:

(11) If this scheme is correct, then the orientation of the heme plane will almost be parallel to the...

(12) Viewed in this way, the concept of latral heterogeneity becomes obsolete because the distinction between gramal and stromal ...

(13) ... approx 70% according to our method and some β -turn ...

The most commonly employed strategy is to comment on the uncertainties of the experimental conditions, by either failing to guarantee results (14) or withholding endorsement of the decisiveness of claims (15):

(14) We did not succeed in obtaining the complete transcript.

(15) So it is difficult to conclude whether the 100 kDa protein mentioned above is actually the EF-2.

The variation of forms used to express these strategies and the fact they are not neatly quantifiable means their significance has been overlooked in the literature. They should, however, be considered among the hedging devices available to scientific writers.

Rhetorical distribution of hedg ^~

The distribution of hedging in the conventional Introduction-Methods-Result-Discussion structure of RAs demonstrates their rhetorical use. The highest frequency occur in the Discussion sections where

authors' make their claims and explore implications not directly tied to experimental findings (Table 4). 82% of all items occur in the Results and Discussion sections with only 4% in methods. In RAs with an IMRD organisation, Discussions averaged 36 devices per thousand words with Introductions and Results yielding 20 each.

Table 4: Overall distribution of hedging in various sections

	Totals	RA Section ¹				R and D ²
		Intro	Methods	Results	Discussion	
Total words	71,635	8,989	17,904	16,791	15,770	12,181
Total Devices	1,474	180	61	336	574	323
Percentages	100	12.2	4.1	22.8	38.9	22.0
Devices per 1000 words	20.6	20.0	3.4	20.0	36.4	26.5

¹ Figures excluded for one RA which did not conform to the IMRD structure.

² Includes 10 RAs with combined Results and Discussion sections.

In the four part texts, 60% of epistemic modal verbs, 52% of modal nouns and 46% of adverbs are found in Discussions. While the density of items in Results sections is about a quarter of that found in Discussions, 42% of lexical verbs and 52% of references to limiting experimental conditions are found here. A breakdown is shown in Table 5.

This distribution is explained by the different rhetorical purposes served by these sections, with judgements and comments predominating in the more discursive sections. The distribution varies but is always highest in Discussions with modal verbs (7.8 per 1,000), adverbs (7.7), lexical verbs (7.1) and adjectives (6.6) particularly prominent here. It is in Discussions that authors gain their academic credibility by going beyond the data to offer more general interpretations. In Introductions hedging largely mitigates reviews of prior research, speculates about the importance of the study and tentatively announces findings. Result sections are where new knowledge is presented and here hedges anticipate reader challenges by limiting the claims made for methods and results. Methods is the least obviously rhetorical section and also the least modalised, with one tenth of the density of epistemic items found in Discussion sections.

Table 5. Distribution of various devices

Epistemic Category	RA Section ¹ (devices per 1,000 words)					Average per RA ²	Raw totals
	Intro	Methods	Results	Discussion	R and D		
lexical verbs	4.9	0.6	5.7	7.1	6.2	14.1	337
adverbs	4.0	0.6	4.0	7.7	6.1	12.7	313
adjectives	3.7	1.2	4.3	6.6	4.3	11.3	285
modal verbs	2.8	0.0	2.4	7.8	3.9	9.7	237
limiting conditions	0.6	0.3	1.4	2.1	2.1	3.7	91
modal nouns	1.7	0.2	0.6	2.2	1.5	3.3	82
model, method, etc	1.0	0.4	1.2	1.8	1.1	3.2	79
lack of knowledge	1.3	0.1	0.4	1.1	1.3	2.1	53
Totals	20.0	3.4	20.0	36.4	26.5	60.1	1477

¹ Figures have been excluded for one RA not conforming to the IMRD structure.

² Includes all 26 articles in corpus.

NNSS and hedging

The significance of these findings to ESP teachers should be clear. Foreign students find the expression of commitment and detachment to their propositions notoriously problematic and a failure to hedge statements adequately is a common feature of L² writers, even those who have a good control of English grammar and lexis. This can seriously hamper a student's participation in a research world dominated by the international lingua franca of English. The main reason for this failing is that the discourse features of academic writing are culture specific. The contrastive rhetoric literature suggests that ESL students at various proficiency levels transfer writing strategies from their L¹ to the L² and this occurs whether the strategies are effective or not. This results in what Thomas (1983) calls cross-cultural pragmatic failure, or the inability to say what one means. This is particularly well documented in spoken discourse where it may be due to either inadequate linguistic knowledge or to faulty perceptions of culturally appropriate behaviour.

What Thomas refers to as "Pragmalinguistic failure" is a problem of inadequate linguistic knowledge and essentially involves different interpretations of equivalent speech acts. So for example in presenting a knowledge claim, a writer may select a strategy which conveys the right illocution but has the wrong degree of politeness. In essence, students just don't have the language to say what they want to say. Arab students, for example, appear to have difficulties in this area:

in addition to lacking a complete repertoire of hedges, the L² speakers in our study lacked a knowledge of their semantic function and distribution.

(Scarella and Brunak, 1981: 67-8)

"Sociopragmatic failure" on the other hand stems from cross-culturally different perceptions of what constitutes appropriate linguistic behaviour. L² students may have false perceptions of appropriate formality, directness, deference and other pragmatic rules required simply because they learn to think and write differently in their own cultures. So NNSs may have:

false expectations of the social relationships and concomitant social behaviour required within the discourse community because of the different rules which operate within parallel communities in their own culture.

(Bloor and Bloor, 1991: 8)

Bloor and Bloor consider the degree of indirectness and concession permitted in academic writing a clear source of cultural difference and observe that Czech research articles display a more direct, unhedged style while Robberecht and Peteghem (1982) refer to the difficulties faced by Dutch and French students in mastering hedging in English. On the other hand, preferences for non-linear indirectness and tentativeness in argumentation have been confirmed for speakers of Japanese (Hinds, 1983), Korean (Egginton, 1987; Choi, 1988), Finnish (Ventola, 1992; Mauranen, 1993), Arabic (Ostler, 1987) and German (Clyne, 1987). Such differences may be related to the notion of reader involvement and whether responsibility for communication rests with the reader or writer (Hinds, 1983; Clyne, 1987).

Hedging thus represents a major "rhetorical gap" that L2 students have to cross before they can gain membership of a discourse community and pursue their chosen careers.

Issues and solutions

Clearly the ability to hedge statements appropriately is essential to effective communication and therefore to academic success but the acquisition of unfamiliar cultural and linguistic rules allows no instant solutions. Any response however must involve three major areas.

Firstly, science faculties need to acknowledge the significance that cultural differences have on the ability of students to communicate effectively. Until recently university departments largely ignored differences between students' and subject cultures, perhaps because of the traditional view which saw science as an independent culture expressed by a single discourse. Widdowson (1979: 61), for example, has been influential in ESP in promoting the notion that science is expressed by a "universal rhetoric".

However, scientific research does not exist outside of writing, therefore it cannot be realised without being influenced by the cultures which convey it. Science faculties have to recognise that students may possess an inadequate awareness of the variations in the sociopragmatic rules of language use. Students can only develop appropriate discourse strategies if they understand the needs of academic audiences, but studies show that classroom writing contexts are often artificial with little purpose other than to display knowledge. Most science undergraduates for example only write reviews, lab reports and project proposals and have no experience in argumentation. There is a clear need for subject lectures to provide written work which varies both purpose and audience.

Secondly, ESP teachers also need to move beyond a view that scientific writing is simply detached and factual and the idea that hedges are merely conventions of an academic culture. Unfortunately few published ESP courses discuss interpersonal aspects of writing and it is still rare for students to be taught explicitly about hedging. ESP materials are almost universally weak in this area and provide inadequate information and explanations which misrepresent the importance of both the concept and different devices. ESP teachers and materials writers have to acknowledge the importance of hedging and ensure students recognise this importance. Once again, we need to focus students on audience needs, particularly the degree of precision, caution and deference expected, by encouraging authentic writing tasks and the evaluation and manipulation of model texts.

Finally, we must look towards applied linguistics for analyses of hedges and their role in genre construction. A major reason why students do not get systematic training in the use of hedges is because we lack empirical information about the rules of various speech communities. Much of the attention given to hedging has been theoretical, refining conceptual distinctions by focusing on intuitive and decontextualised examples. Corpus studies, on the other hand, have either included a heterogeneous range of registers, or have centred on descriptions of spoken discourse or modal verbs. What are urgently needed are explanatory and descriptive accounts of the use of hedging in different registers based on analyses of authentic written sources.

Conclusions

The need to carry out research and publish results in English language journals presents NNSs with serious problems for they have to work within an unfamiliar cultural and linguistic environment. The RA is the key genre in academic disciplines and a NNS who wishes to function in the international research world must be familiar with its conventions and be able to recognise and use hedging devices appropriately. To achieve this however, our understanding of the concept needs to be sharpened and informed by granting hedges a higher priority in both our teaching and research agendas.

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